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Performance Enhancement For Ship Repair/Conversion Processes

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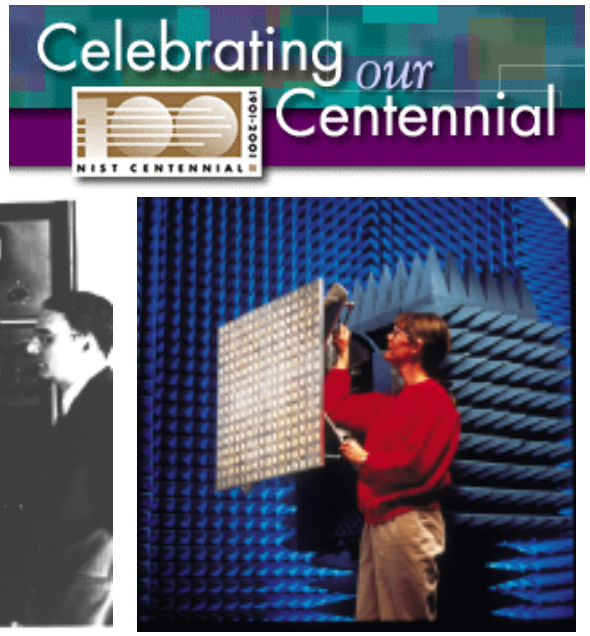
Department of Commerce

Presentation Outline

- Organization: NIST, MEL, ISD
- NSRP ASE Joint Project
- Performance Enhancement: Flying Carpet
- Next Steps

NOTE: NIST does not endorse products. Products are used for illustration purposes only and are not mentioned because they are better than another similar product.

Atomic Clock



Antenna Design

Fire Safety

Robotics And Automation

- 100 years old this year, was National Bureau of Standards
  - ... to end confusion in the marketplace and improve products that were unreliable or poorly made.

    e.g., In 1901, 8 different standards for the gallon
  - since 1949, kept time for nation with cesium-based clock

    accurate to one second over nearly 20 million years.
  - Nobel Prizes in Physics: Bill Phillips in ‘97; Eric A. Cornell in ‘01

Laboratories

Director

ATP, MEP, Tech. Services, Baldridge Award, Boulder Lab's

Electronics & Electrical Engineering

Building and Fire Research

Materials Science and Engineering

Physics

Information Technology

Manufacturing Engineering

Chemical Science and Technology

Divisions

Precision Engineering

Manufacturing Metrology

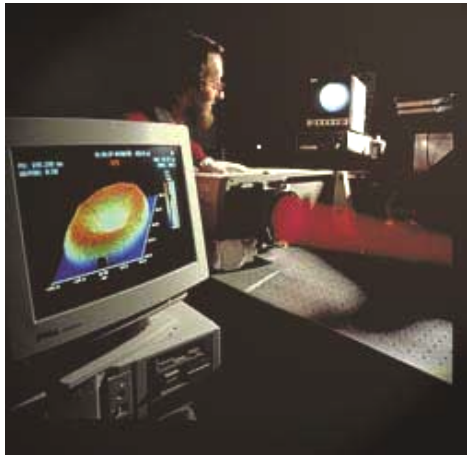
Intelligent Systems

Manufacturing Systems

Fabrication Technology

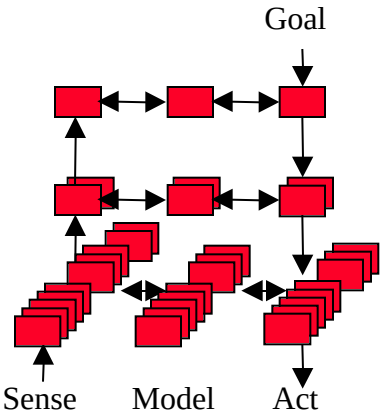
Manufacturing Engineering Laboratory

• To satisfy the measurements and standards needs of ... manufacturers ... by conducting R&D, providing services, and participating in standards activities.
• Over 400 professionals, support staff and guest researchers.



Intelligent Systems Division

• To develop the measurements and standards infrastructure needed for the application of intelligent systems by manufacturing industries and Government.

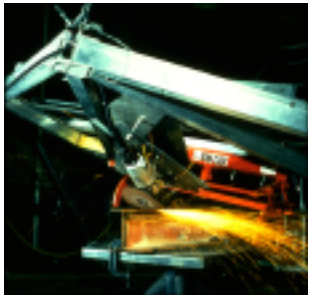


ISD Programs

- **Research and Engineering of Intelligent Control Systems**
  - Enhanced Machine Control
  - Knowledge Engineering
  - Reference Model Architecture for Manufacturing

- **Intelligent Open Architecture Control of Manufacturing Systems**
  - Hexapod
  - NGIS

  - RoboCrane
  - Welding



- **Intelligent Control of Mobility Systems**
  - *Military:* Demo III Project (Army)
  - *Transportation:* Department of Transportation Project
  - *Manufacturing:* Industrial Autonomous Vehicles Project

"Knowledge Based Modular Repair Project"

- Within: "NSRP's flagship R&D program, Advanced Shipbuilding Enterprise, is focused on improving the commercial competitiveness of the U.S. shipbuilding industry, thereby reducing the cost of Navy ships." *(www.nsrp.org)*
- Team: Atlantic Marine H.C. and NIST - Aug. 99 to May 02
- Goal: To identify, develop, and deploy reverse engineering techniques, controlled manufacturing processes, and knowledge-based models to improve the ship repair and conversion process. *Expected benefits:* Reduced time, cost, and rework.

Problem

• Ship bow and stern are difficult and inefficient to access with conventional stick-built scaffold methods.

• Ship upper sides can also be difficult.

• *Example*: Observed more than 1 shift (8 hrs.) x 8 people to assemble single, fixed 80 foot tower to ship bow on dry dock = *64 person-hours total*.

• ***Solution***: "**Flying Carpet**" - takes an estimated 1 hour x 3 people to set-up = ***3 person-hours total***.

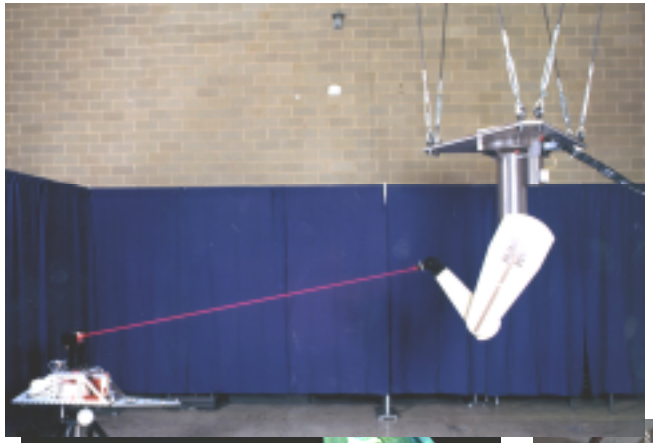
• PLUS: Flying Carpet provides maneuverability of people and heavy loads (steel plate, equipment, ...) with simple joystick control.

Combining Technology: *Flying Carpet Basis*

NIST RoboCrane Technology

Constrained platform motion from rigging

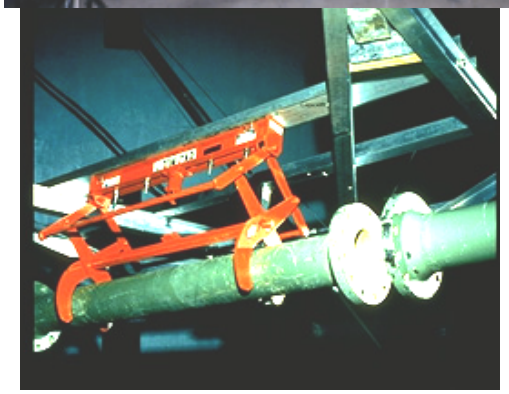
Ref: NIST Tech. Note 1267



... including,

RoboCrane platform control

Precision joystick and programmed control demonstrated



Combined with...

Commercial Scaffold

Photos Courtesy:

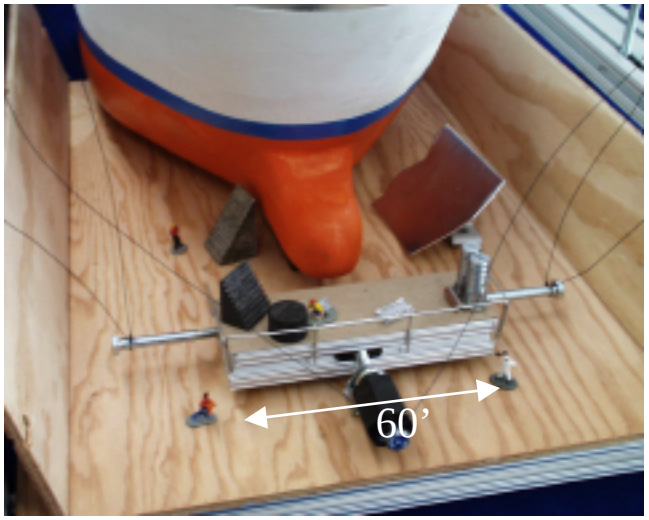
and Courtesy: New York Ladder & Scaffolding Corp.

Solution: NIST Flying Carpet

Flying Carpet *Expected* Features

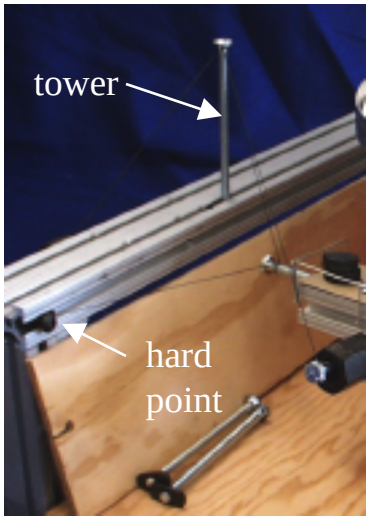
- Joystick controlled
- 50’ x 2’ modular platform
- 6 ton max. payload
- 70 feet or more working height (tower ht. depend.)
- ±15° Yaw (bow/stern)
- Dry Dock mount allows some pre-set-up and reconfigurability
- Platform weight: 3 tons
- Stable in 6 DOF

Flying Carpet Set-up Sequence

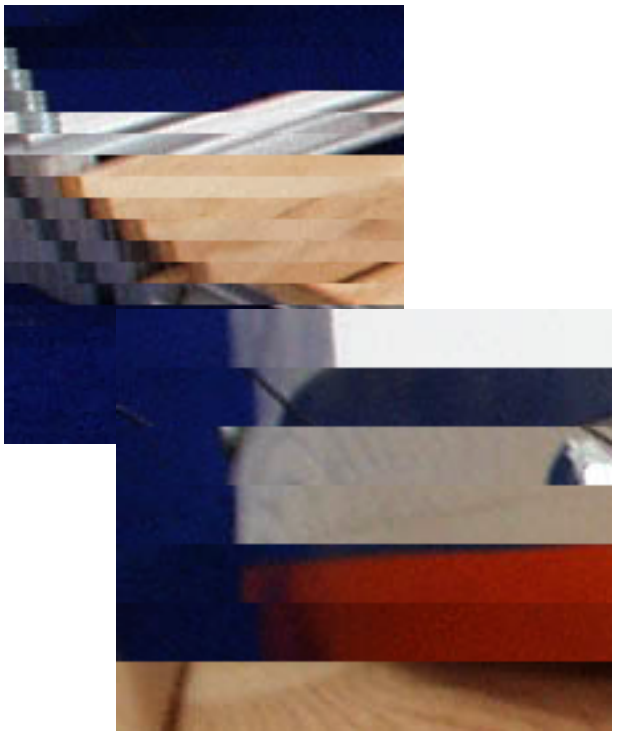


1. Flying Carpet is craned or wheeled to dry-dock; Cables are handed to workers at dry-dock sides.

Note: Some pre-set-up (i.e., tower installation) can occur prior to ship arrival!



2. Two 40’ tall towers are installed on dry-dock sides; Cables are attached to two towers and two dock hard points.

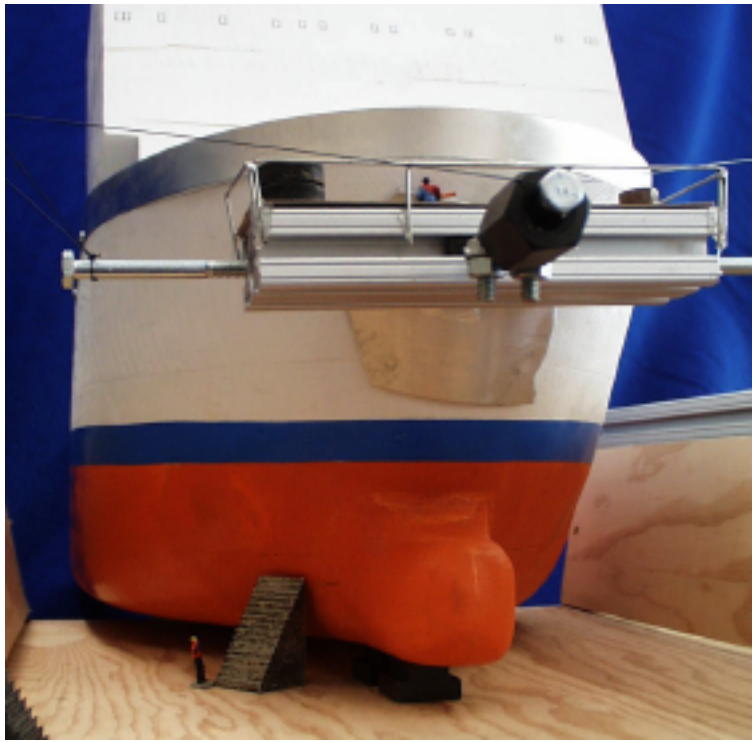


3. Cables are tightened using controller; Flying Carpet is ready to use with simple joystick control.

Ship Bow/Stern Access

Workers installing and finishing a heavy steel plate with joystick-controlled Flying Carpet

Clearance beneath Flying Carpet for platform maneuverability and/or simultaneous work below platform



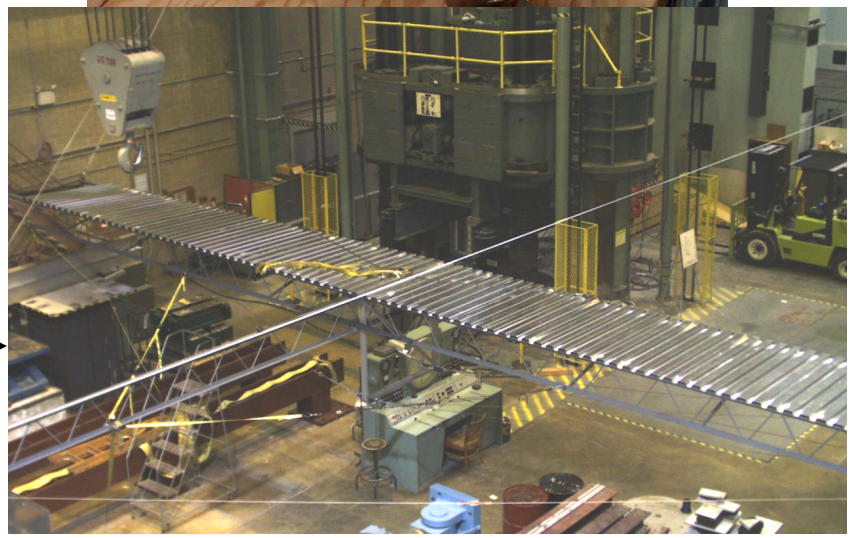
Flying Carpet Stern Access

Flying Carpet Scale Models

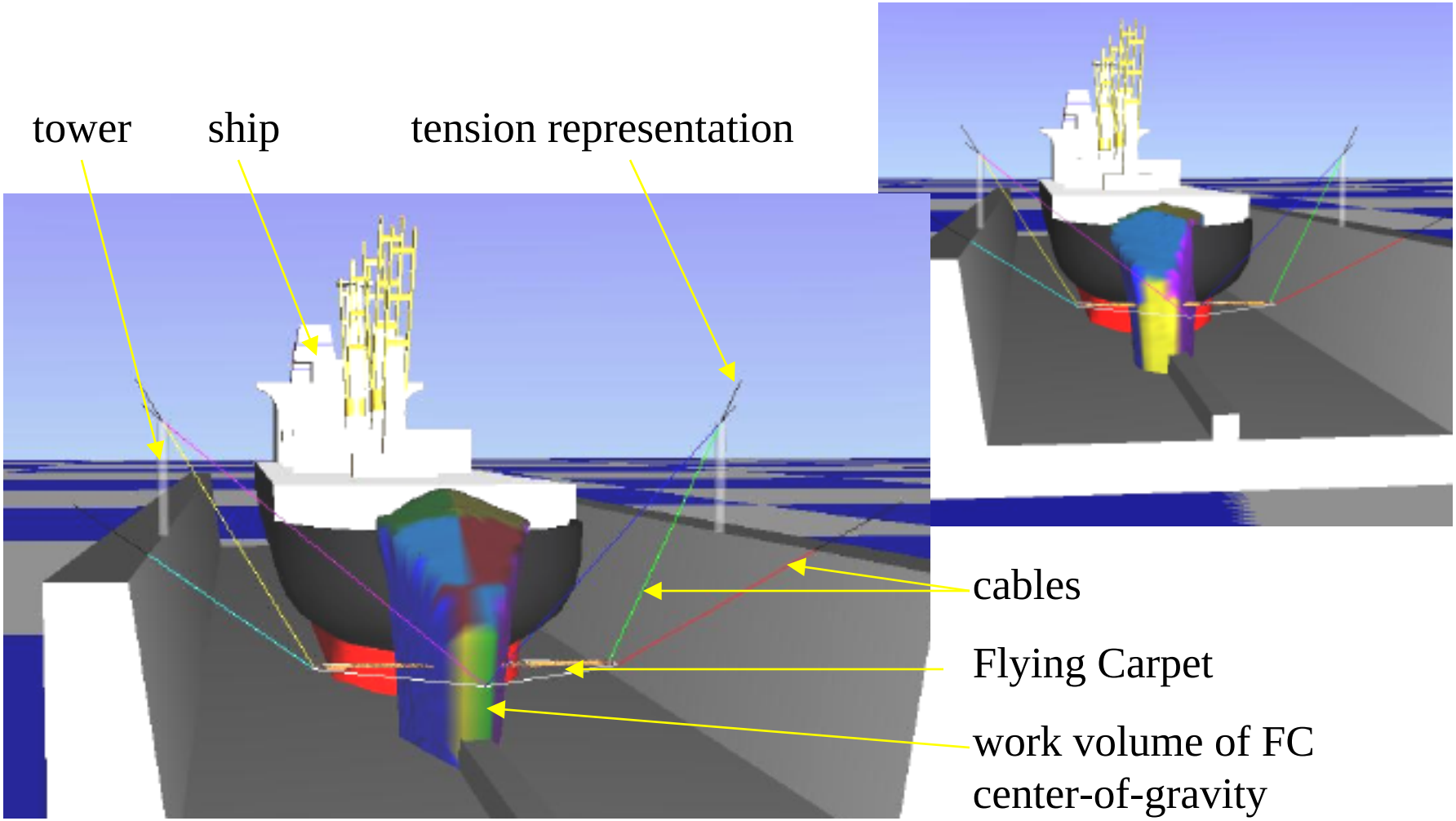
- 1/120th scale (table-top) static model built - for feasibility, rigging, and overall concept study

- 1/40th scale moveable model built - for platform work volume limits and rigging study

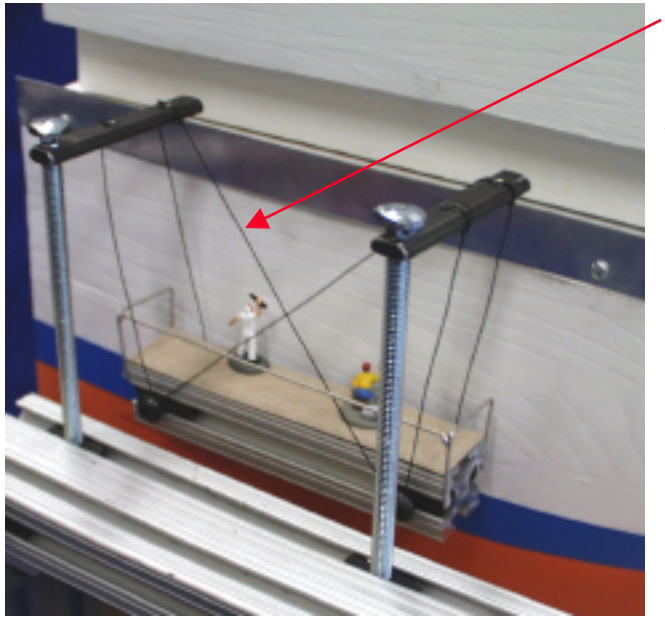
- Full scale testbed (50’ x 5’) built - for static measurement and computer model verification



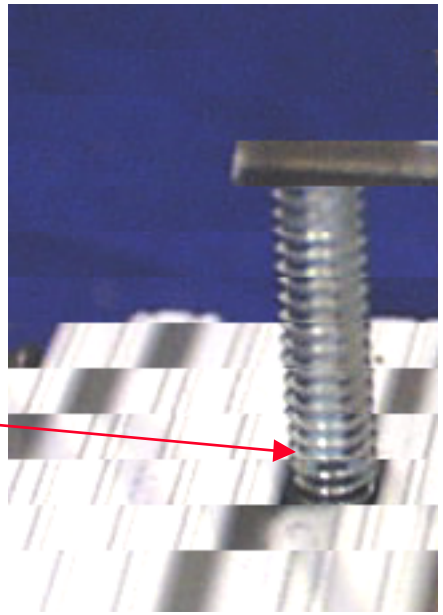
Computer Modeling



Ship Side Access: dry dock-supported



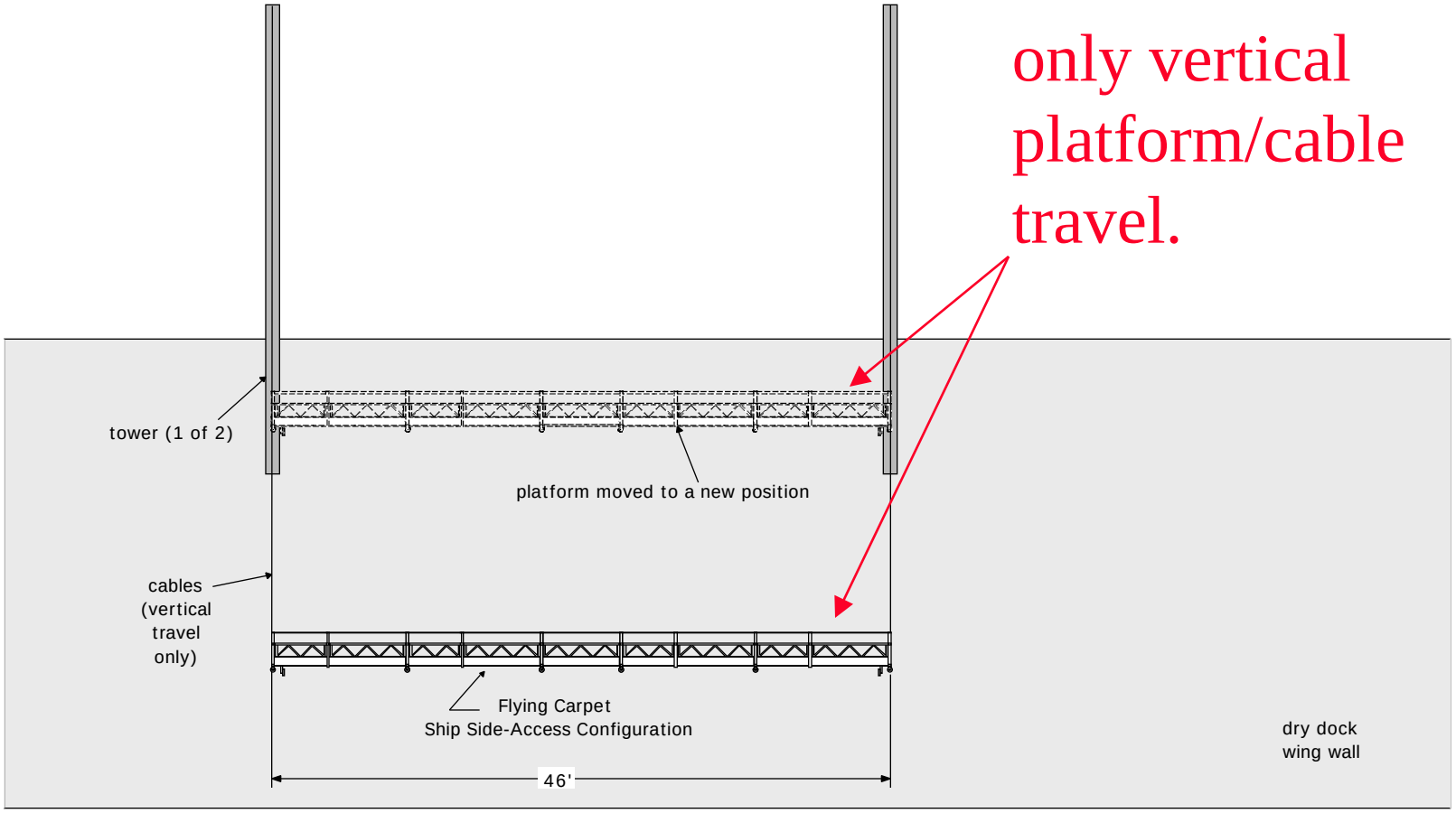
- Cross-cables (atypical) allow stiffer system side-to-side
- Joystick control automatically pays cables in and out
- Angled cables and/or electro-magnets can provide continuous, front platform-edge, ship-touch.



- Dry-dock-supported system allows pre-set-up prior to ship arrival
- Flexibility of attachment (to dry dock or ship) and ship access points
- Minimal ship-touch to allow side plate installation and/or finish work
- Modular Flying Carpet allows reuse/reconfiguration of system components

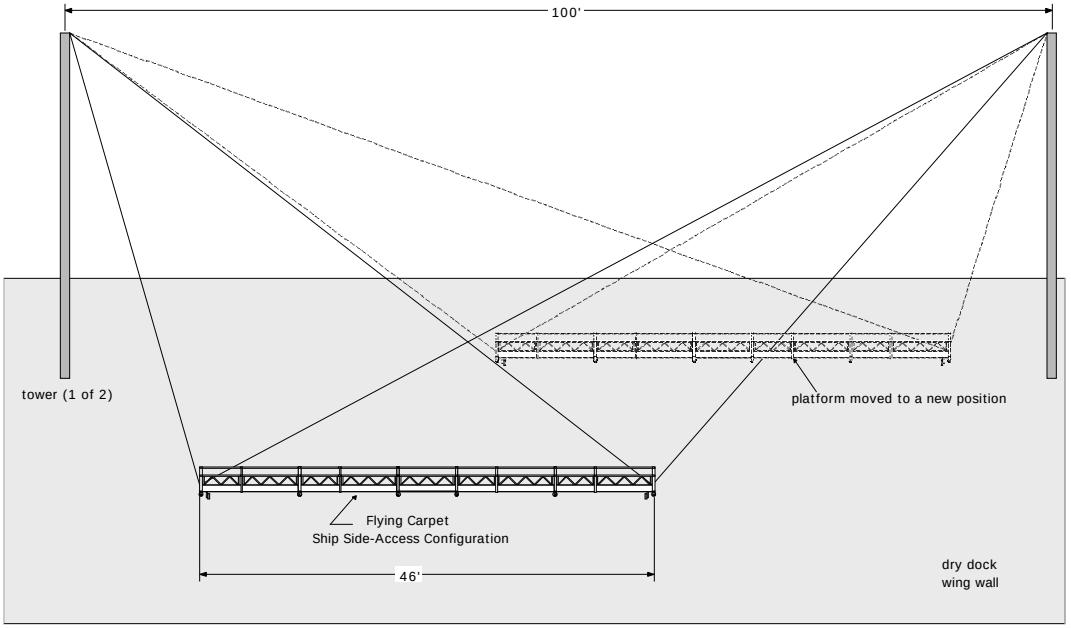
Ship Side-Access

with conventional suspended scaffold

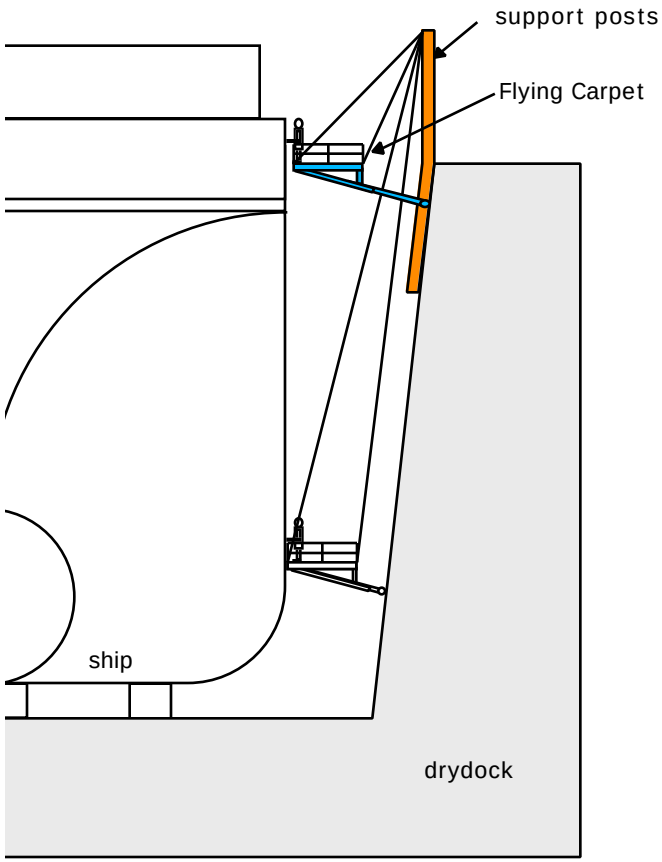


Advanced Ship Side-Access

- Vertical and horizontal platform travel with NIST controller.
- More rigid platform constraint.



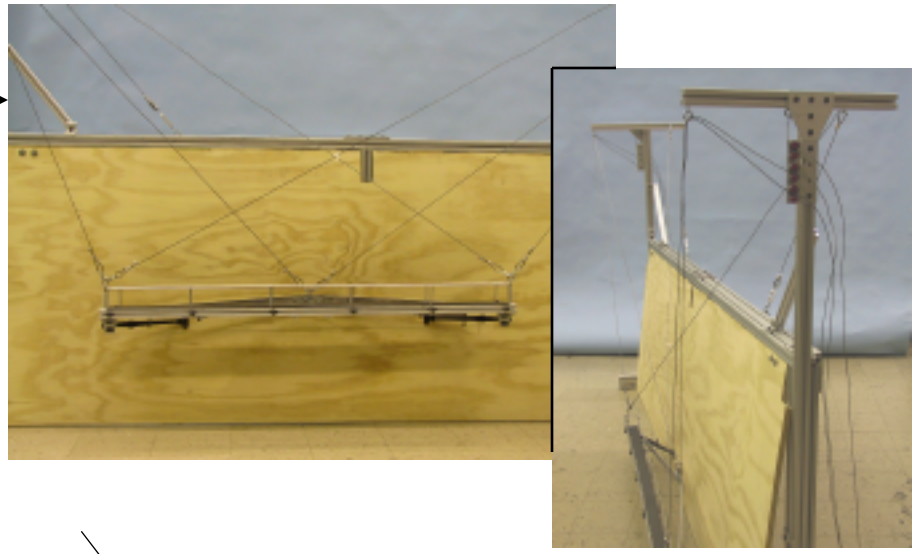
front view



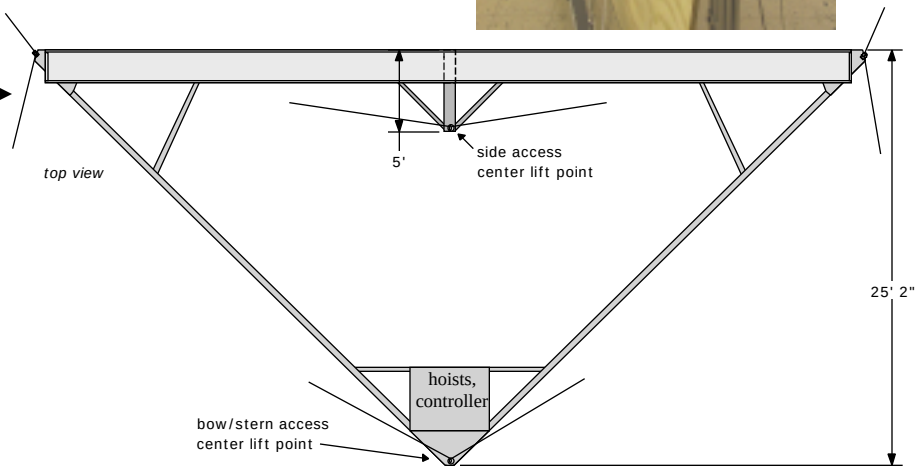
end view

Phase 2 Flying Carpet Scale Models

- 1/12th scale moveable model built - for feasibility and rigging concept study of ship side access configuration



- Full Scale Phase 2 testbed - for control study of both ship bow/stern and side access configurations (May 02 deliverable)



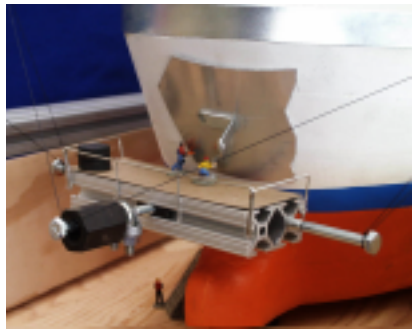
Phase 2 Flying Carpet Spec's

Two Configurations:

Ship side access

- 6 support cables, two-part lines
- hoist-controlled cable lengths (1500 lb. working-load hoists x 2 part line for 3000 lb. total hoist capacity)
- two support towers mounted to wing walls
- manually controlled rollers on wheels push off wing wall/supports

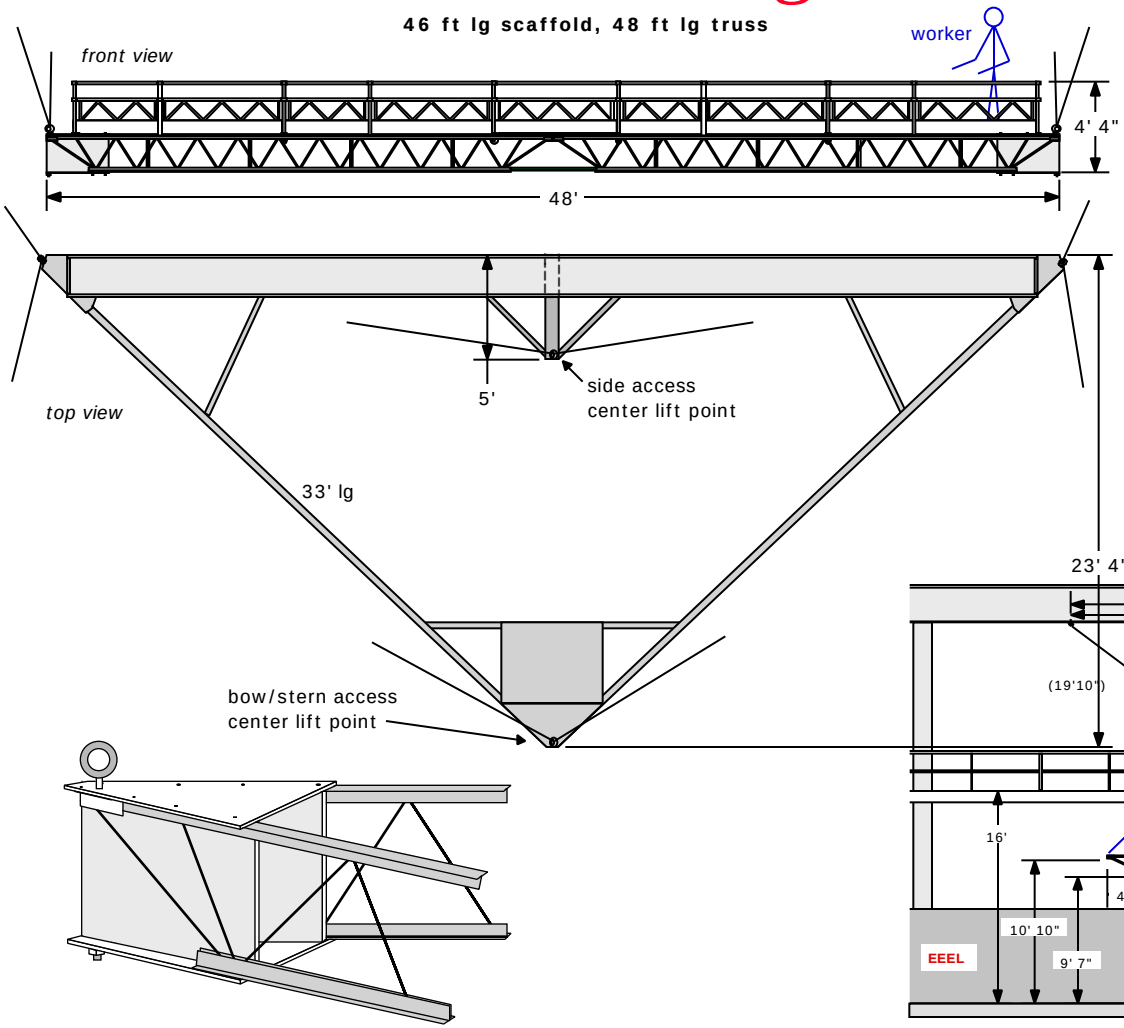
Ship bow/stern access



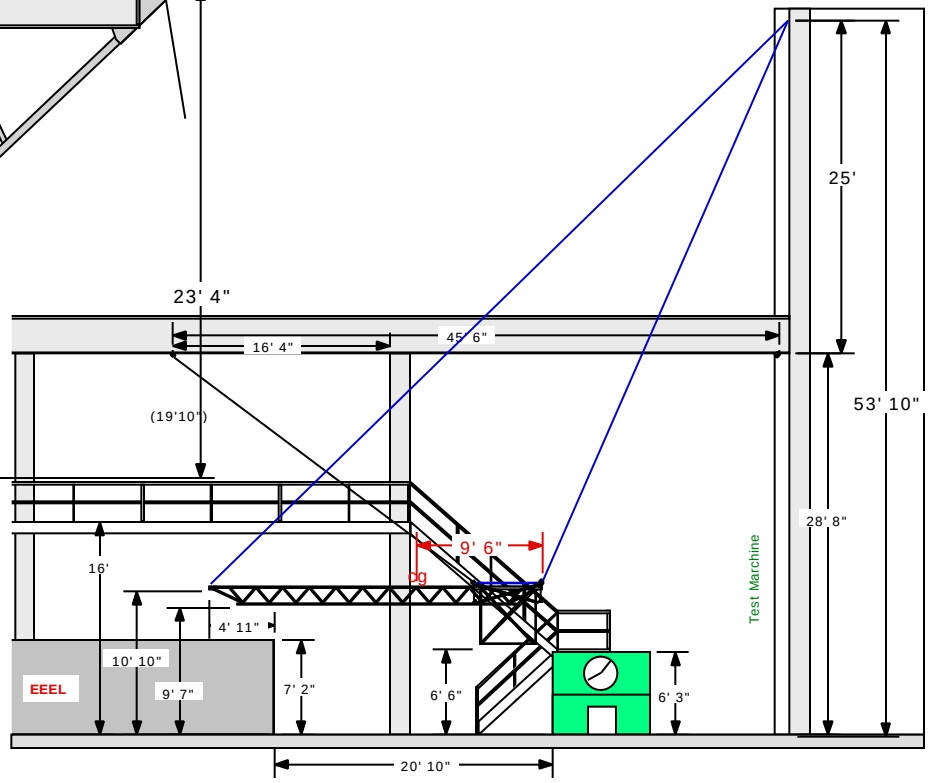
- 6 support cables, two-part lines
- hoist-controlled cable lengths (1500 lb. working-load hoists x 2 part line for 3000 lb. total hoist capacity)
- two support towers mounted to wing walls (4 cables attached, 2 per tower using snatch blocks)
- two cable attachment points on wing walls (one on each wall using snatch blocks)

Phase 2 Testbed Mechanical Design

Phase 2 Design



High Bay Layout



Phase 2 Flying Carpet Spec's

Platform Weight Estimate:

- scaffold:	755 lb. (4ea. 9.75 ft, 1 ea. 6 ft sections) - bolts to top of truss triangle
- truss:	1163 lb. (2 ea. 18K9's at 24 ft = 10.2 lb. x 48 ft = 490 lb. + 2 @ 33 ft = 10.2 x 66 ft = 673 lb.)
- corners:	330 lb. (3 ea. x 110 lb.)
- hoists:	500 lb. (6 ea. x 80 lb.)
- pulley blocks:	240 lb. (40 lb. x 6 ea.)
Total Weight:	2988 lb. (1.5 t)

Platform Size: 48' wide x 24' (5' for side access) deep x 5' high

Platform Payload: 750 lb. {limited to scaffold payload}

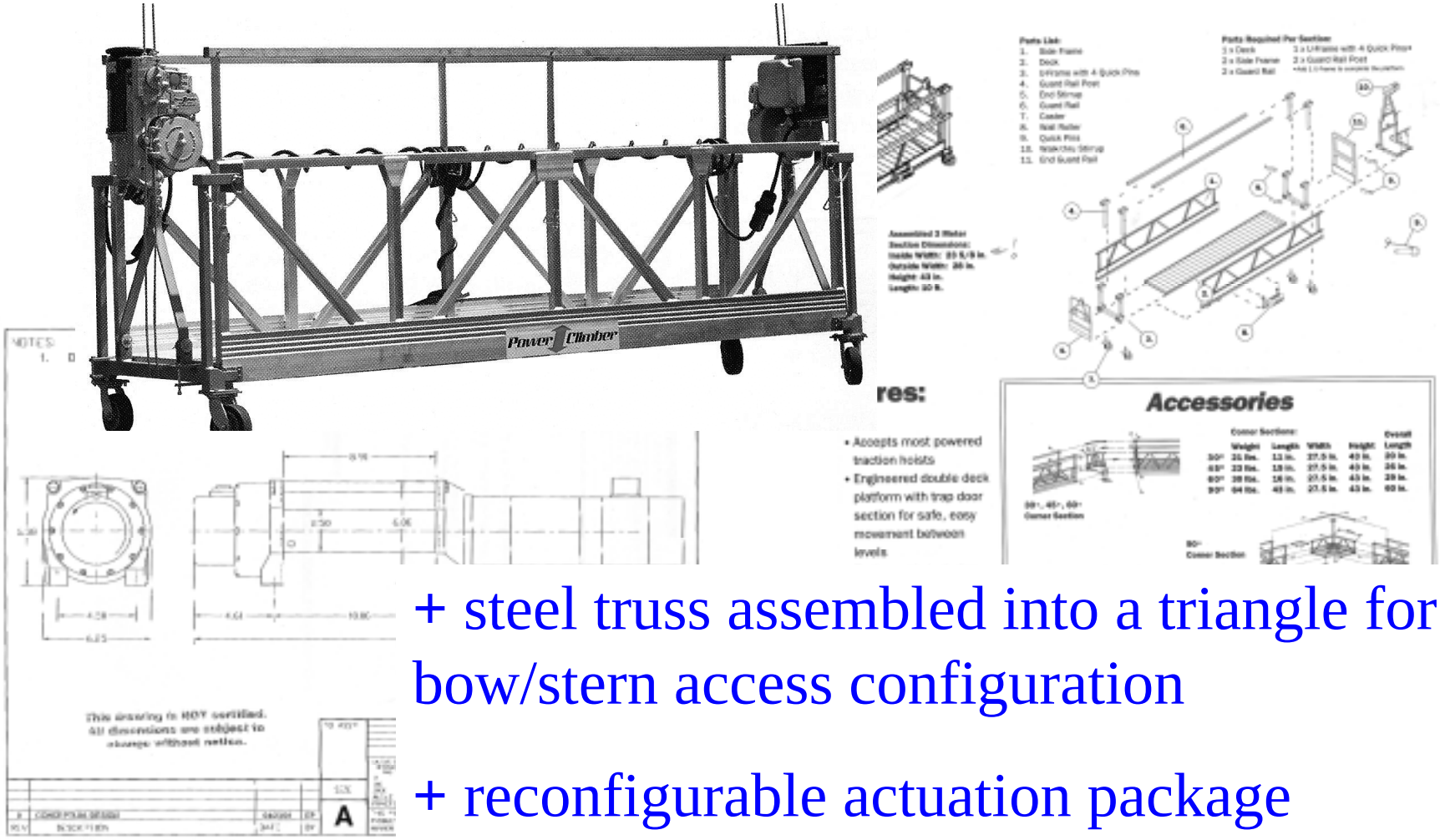
(2 tons avg., 6 tons max. desired max. payloads)

Scaffold: OSHA approved

Vertical Load Safety Factor: 4.8 (with 6 hoists), 2.4 (with 3 hoists) - 750 lb. payload

Controls: 4-axis Joystick operator interface, 2 tilt angle (roll/pitch) constrained & redundant (sensor, kinematics), PC104 w/Linux OS, CAN- or serial-controlled servo

Designs *build on conventional equipment*

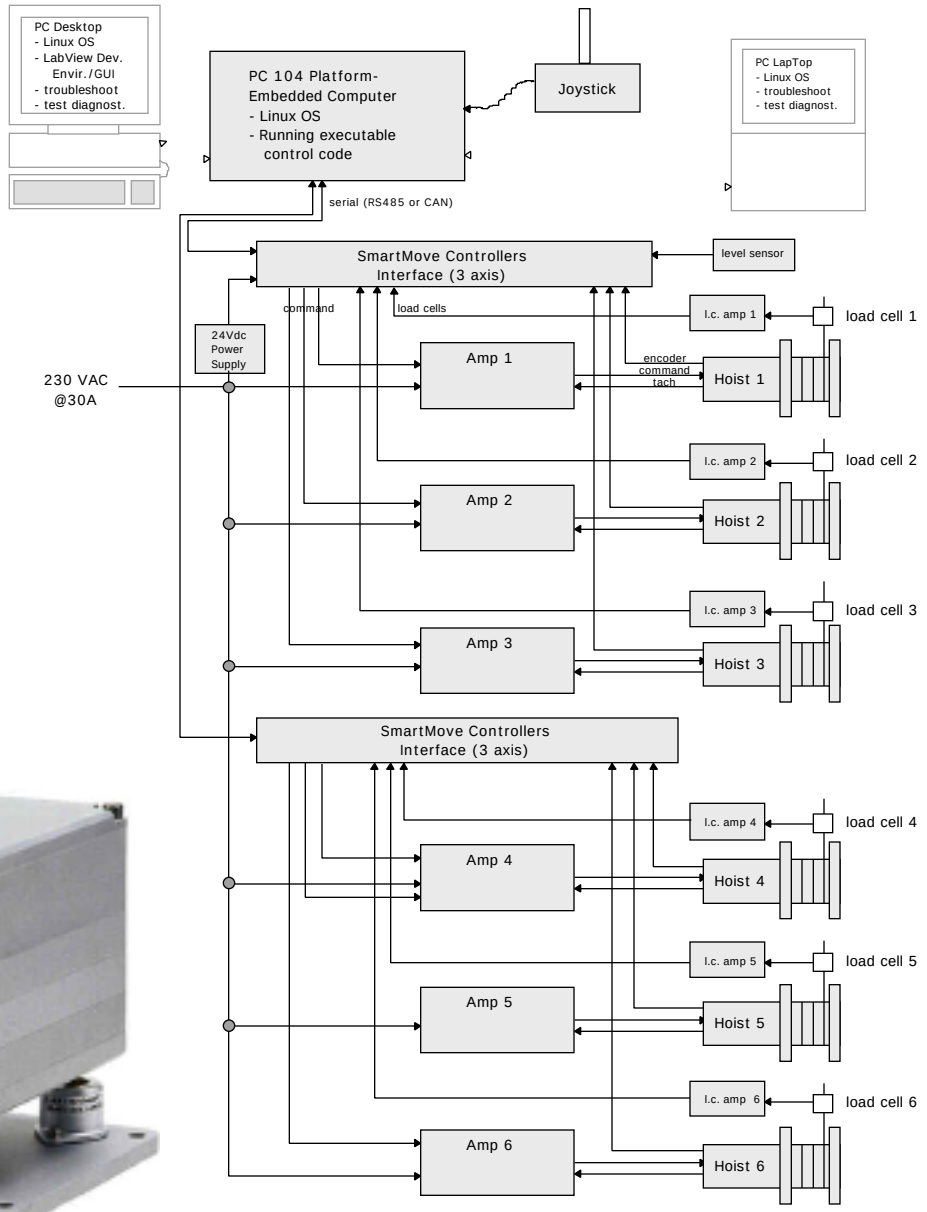


+ steel truss assembled into a triangle for bow/stern access configuration

+ reconfigurable actuation package

Controls

- Same controller as Air Force Platform project
- PC 104 embedded computer,Linux OS, kinematics
- Desktop,laptop for develop./tblsht only
- Sensors: hoist-motor encoders, angle, load cells
- Operator input via joystick



Next Steps

- Build Phase 2 testbed at NIST
  - Initial goal: to measure the static and dynamic constraint of a large-scale platform suspended from 4 points - useful for worker- and/or material-access to large structures (ships, aircraft, buildings, towers).
  - Second goal: to study the platform controllability using atypical RoboCrane kinematics.
- Demonstrate to invited shipyards, Navy, and other industries in June 2001.
- Transfer technology through cooperative agreements, licenses, etc. with industry manufacturer/maintainer for supply to shipyards.

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http://www.isd.mel.nist.gov/projects/robocrane/shipbuilding.html